THE ALOHA SYSTEM	Project: ATS-1	CCG/G-44	11 pages
Title: Modem-Radio Interface Design		General Document	June 17, 1974
Author(s): David W. Wax	Checked: Dwwax	Approved:	

Introduction

The purpose of this document is to describe the interface circuits used between the ALOHA ATS-1 Modem and the General Electric VHF Base Station Radio used as the ground station for the ATS-1 link. The pre-emphasis/de-emphasis circuits and compensation circuits used with the transmitter modulator and receiver disriminator will be described. Also the interface control circuits to provide burst transmit control of the transmitter will be described.

Transmitter Signal Interface

The G.E. transmitter uses a phase modulator to synthetically produce frequency modulation of an R.F. carrier. Therefore a constant-amplitude modulating signal will cause the modulator to produce a frequency modulated carrier which has a frequency deviation increasing in proportion to the frequency of the modulating signal. Since this is the desired pre-emphasis characteristic, the modulating signal is applied directly to the modulator with no compensation over the frequency range in which pre-emphasis is desired. However, the receiver de-emphasizes baseband signal components only above about 2 KHz (75 microsecond time constant). Therefore, no pre-emphasis should be applied to signal components below 2 KHz. Thus, the pre-emphasis circuit integrates the applied modulating signal components below 2 KHz so that these components are not pre-emphasized. This integration is limited to the range of 200 to 2000 Hz since frequency components below 200 Hz contribute only a small amount of power in the baseband signal spectrum and may be neglected without introducing any significant distortion of the baseband signal.

Figure 1 is a schematic of the phase modulator as it exists in the G.E. transmitter exciter. Resistors R_A and R_B have been placed in the part of the circuit usually used for input of tone-coded signals, so that data signalling can be easily introduced without disturbing the voice modulating portion of the circuit. These resistors provide a voltage division so that the modulating signal can be carried at a relatively high level on the cable between the radio and the interface circuit. This minimizes noise pickup. A series capacitor, C_A, provides d.c. isolation, since the G.E. radio circuits use a -20 volt signal ground reference. Since the modulating signal is

continuously present and the exciter is on all the time, no switching transients are experienced and a large time constant (low corner frequency) may be used for the a.c. coupling. The reason the exciter is left on continuously is to avoid turn-on transients in the exciter circuits. Burst power output is constrained to switching the output power amplifier which is driven by the transmitter exciter. This circuit arrangement will be described in the section on transmitter control.

The pre-emphasis circuits are shown in Figure 2. Since the modem has a 600 ohm input-output interface, a balanced 600-ohm input circuit is used to match the modem's output impedance.

The input circuit then feeds the signal to the pre-emphasis filtering circuit, which uses R25, R26, and C4 to provide the pre-emphasis characteristic, shown in Figure 3. The signal from this filter is then fed to the output buffer amplifier which uses a 709 amplifier so that full frequency response is maintained for large signal amplitude swings. Adjustment controls are provided to allow zeroing the output swing and adjusting its amplitude in order to obtain optimum deviation from the modulator. An amplitude setting providing about 9 KHz of FM deviation has been found to be optimum for transmission to a receiver with a 20 KHz bandwidth receiver. Any greater deviation places too much spectral power outside of the receiver's bandwidth, resulting in degraded performance.

Receiver Signal Interface

The receiver compensation and de-emphasis circuits are shown in Figure 2. The G.E. receiver discriminator circuit is shown in Figure 4.

The first amplifier in the receive side of the interface circuit buffers the high imedance output of the discriminator so as to provide a low driving

impedance for the following filter circuit. Since the source impedance of the discriminator is more than 100 kilohms, the 47 K feedback resistor of the first amplifier reduces the output signal to about one-half of the input amplitude. Referring to Figure 4, the source impedance can be seen to be formed by the series impedance of the discriminator, R83, R23, and the capacitor C. This capacitor is the d.c. decoupling capacitor used for the purpose of isolating the interface circuit from d.c. offsets in the discriminator output. The time constant of C and the source resistance is about one millisecond, which means the signal acquisition transient due to d.c. shift at the discriminator will decay out in about 10 bit periods (at 9600 bits per second).

The buffer amplifier is followed by an active filter which provides both high-frequency roll-off compensation and de-emphasis. R4, R5, and C2 are used to compensate for the high-frequency roll-off due to the 20 KHz bandwidth IF amplifier and narrow-band discriminator. The measured frequency response out of the discriminator is shown in Figure 5 for two different deviations. Also shown is the compensation response curve and the resultant compensated response at 10.5 KHz deviation. This compensation helps considerably to reduce phase distortion at the 9600 b.p.s. rate. The 3dB response frequency is also moved up from 7 KHz to 16 KHz. R6 and C3 provide a de-emphasis characteristic with a time constant of 70 microseconds. Eye-pattern tests with psuedo-random bit sequences transmitted back-to-back through the modem-transceiver combination indicate good phase linearity with little distortion of the eye pattern.

The output from the filter is directed through a gain adjustment control to a pair of operational amplifiers configured to provide a balanced 600 ohm

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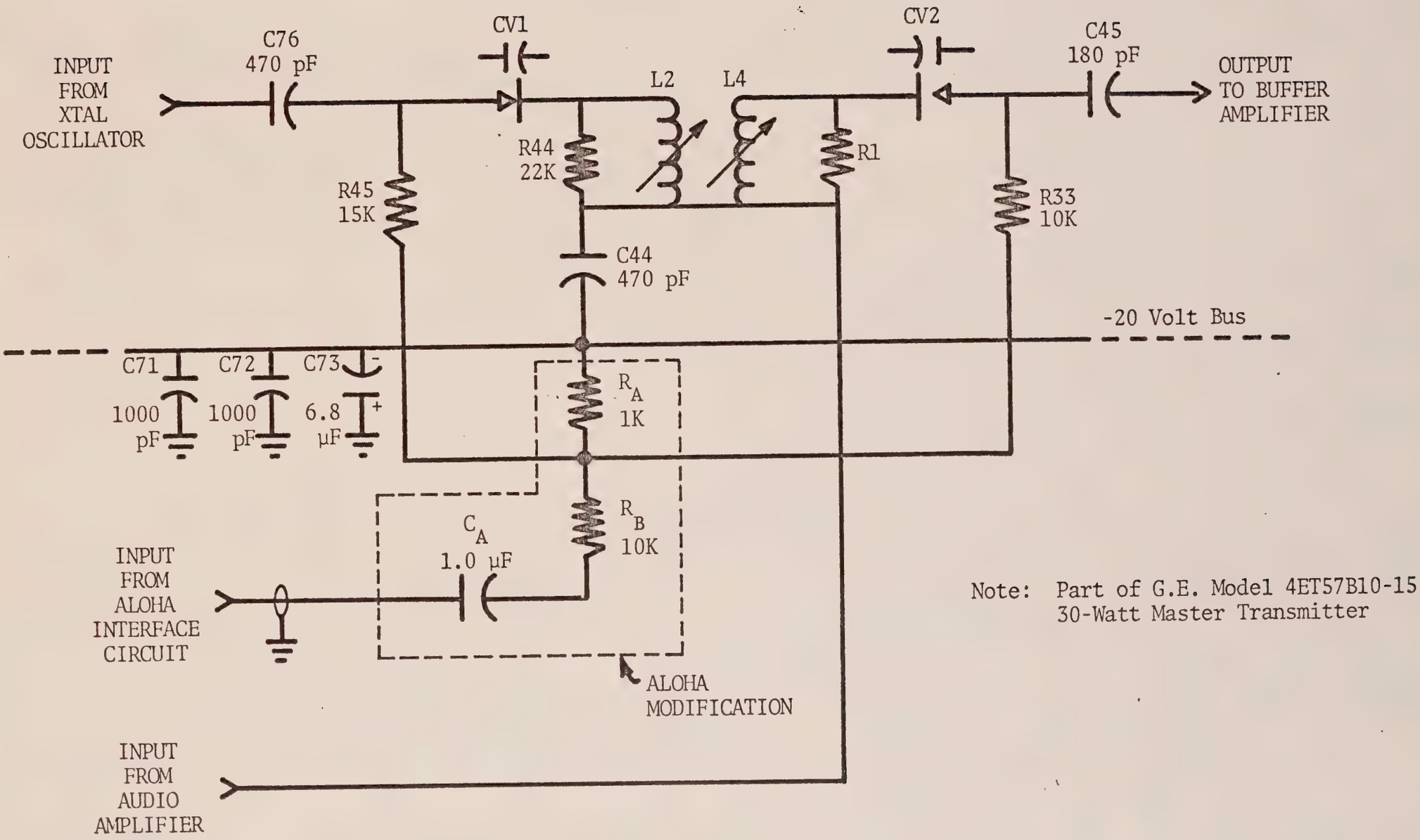
output impedance for interfacing to the modem. The modem signals at the 600 ohm interface are at a level of -10 DBM for both transmitting and receiving.

Interface Control Signals

Two TTL-level signals are used in the interface. One is used to turn on and off the RF transmitter and the other is used to indicate to the modem when the RF transmitting power is above an acceptable threshold for data transmission. The second control signal is necessary since the transmitter's power amplifier must be switched on by means of relays, which have significant turn-on delays. The interface arrangement is shown in Figure 6. The modem control signals are SRT (Request-To-Send, Transmitter) and CST (Clear-To-Send, Transmitter). The modem will not initiate its clear-to-send time-out until an ON signal is received on the CST line.



Note: Part of G.E. Model 4ET57B10-15 30-Watt Master Transmitter

Figure 1

G.E. PHASE MODULATOR MODIFICATION

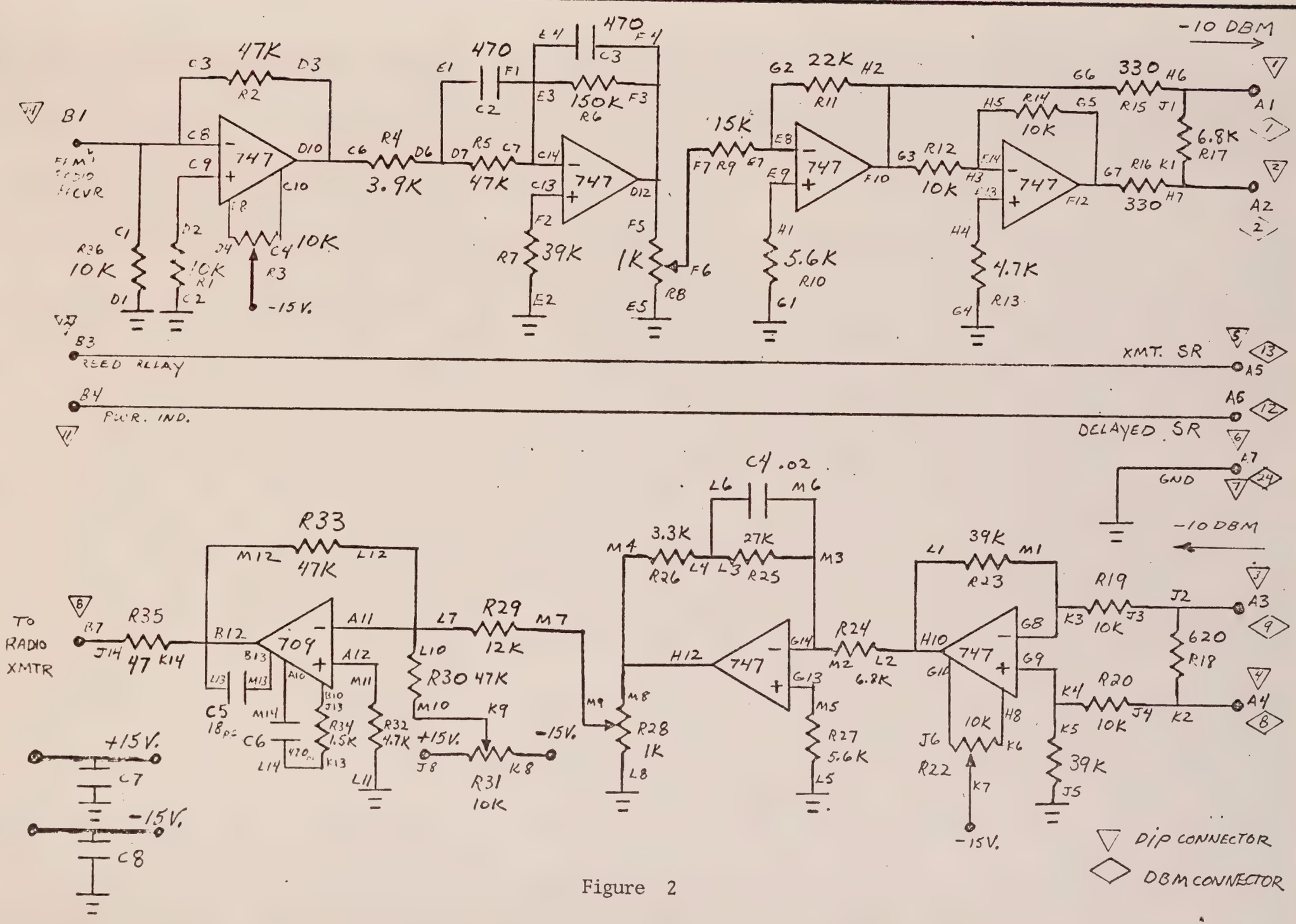


Figure 2

ALOHA System Project, U. of H.
System ATS-1 Hardware
Sub-system INTER-FACE Box
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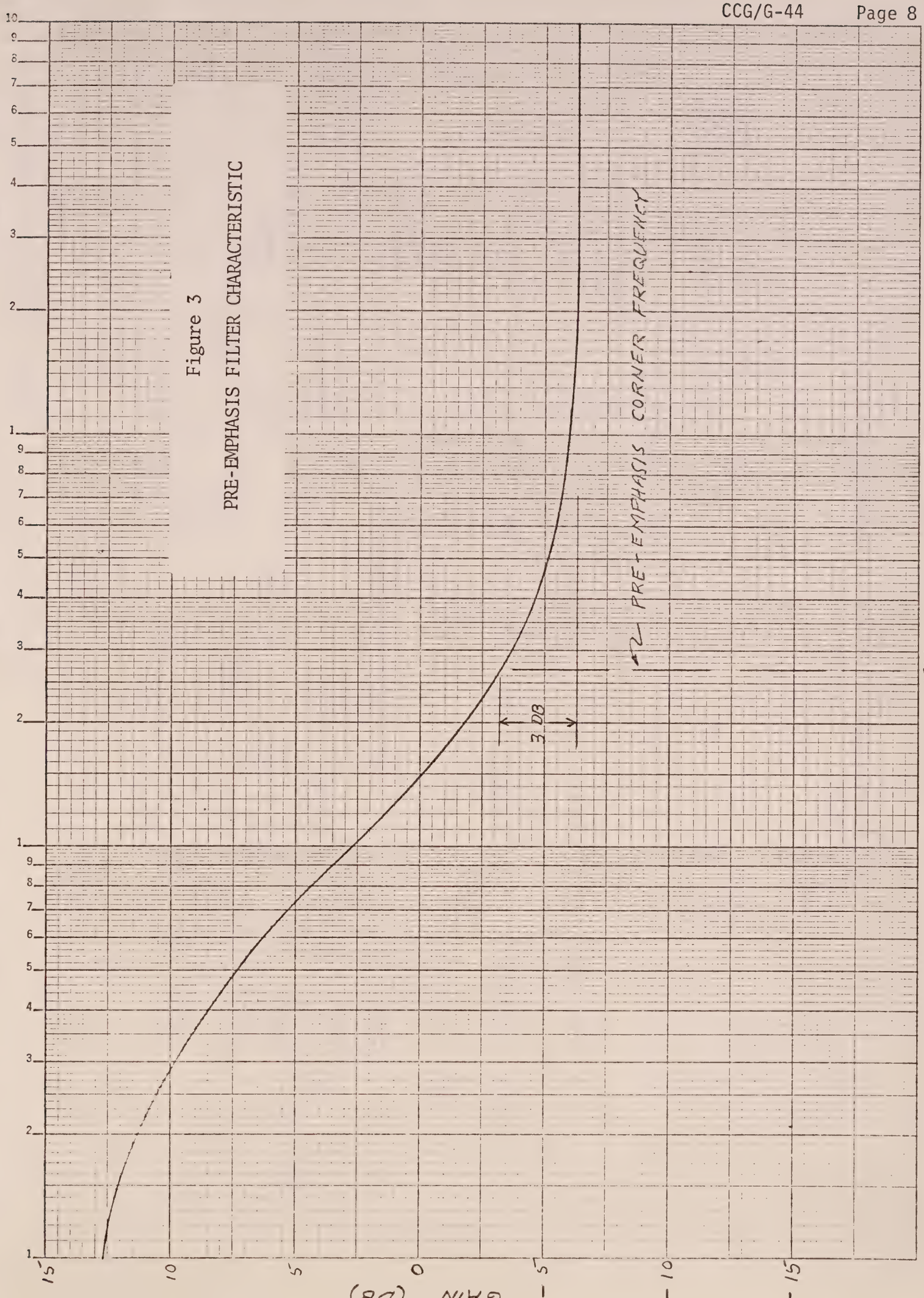

Figure 3

SEMI-LOGARITHMIC 46 5490
3 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

Note: Part of G.E. Model 4ER41D10-15
132-174 MHZ Receiver

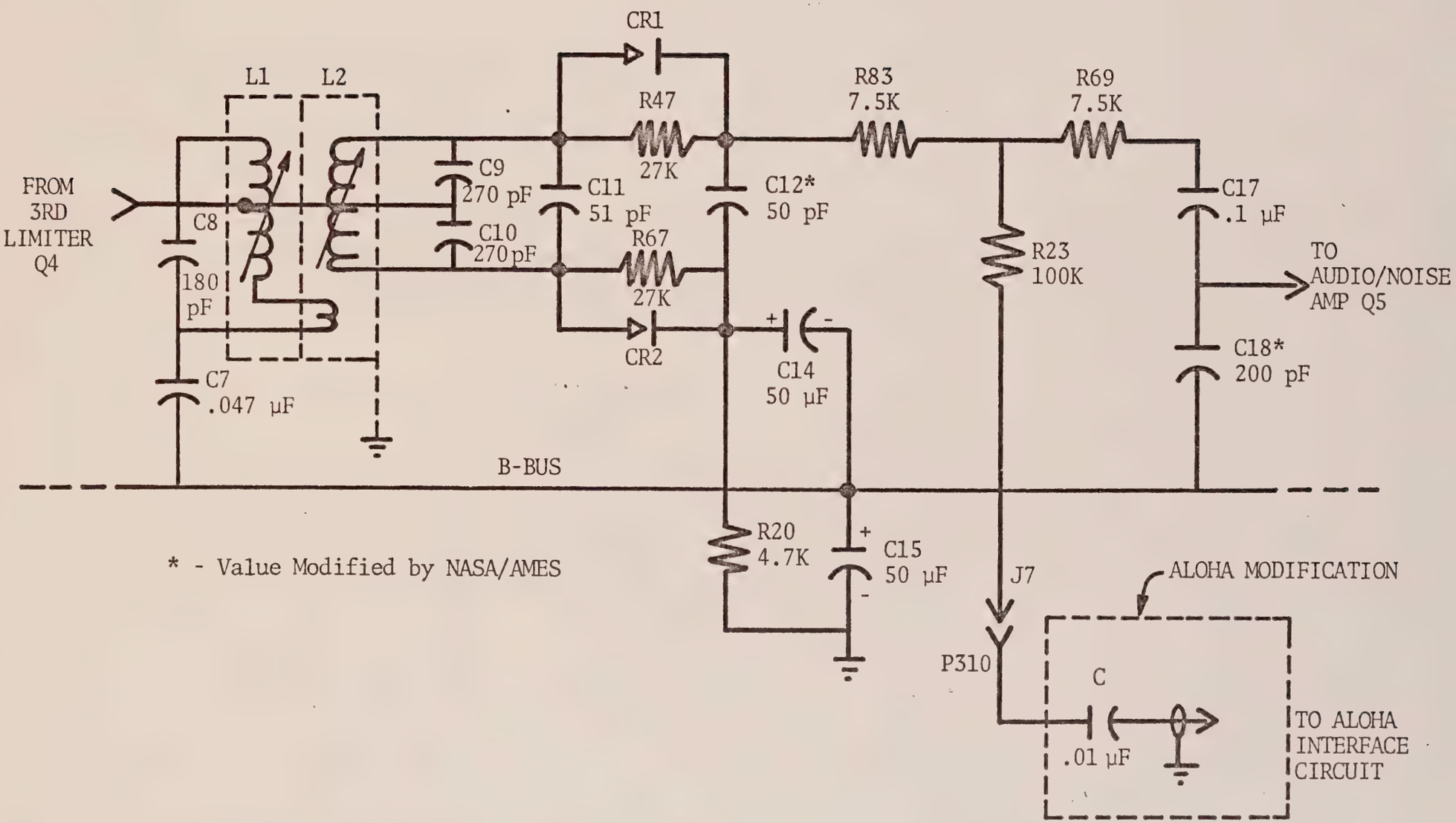

Figure 4

G.E. WIDEBAND RECEIVER DISCRIMINATOR MODIFICATION

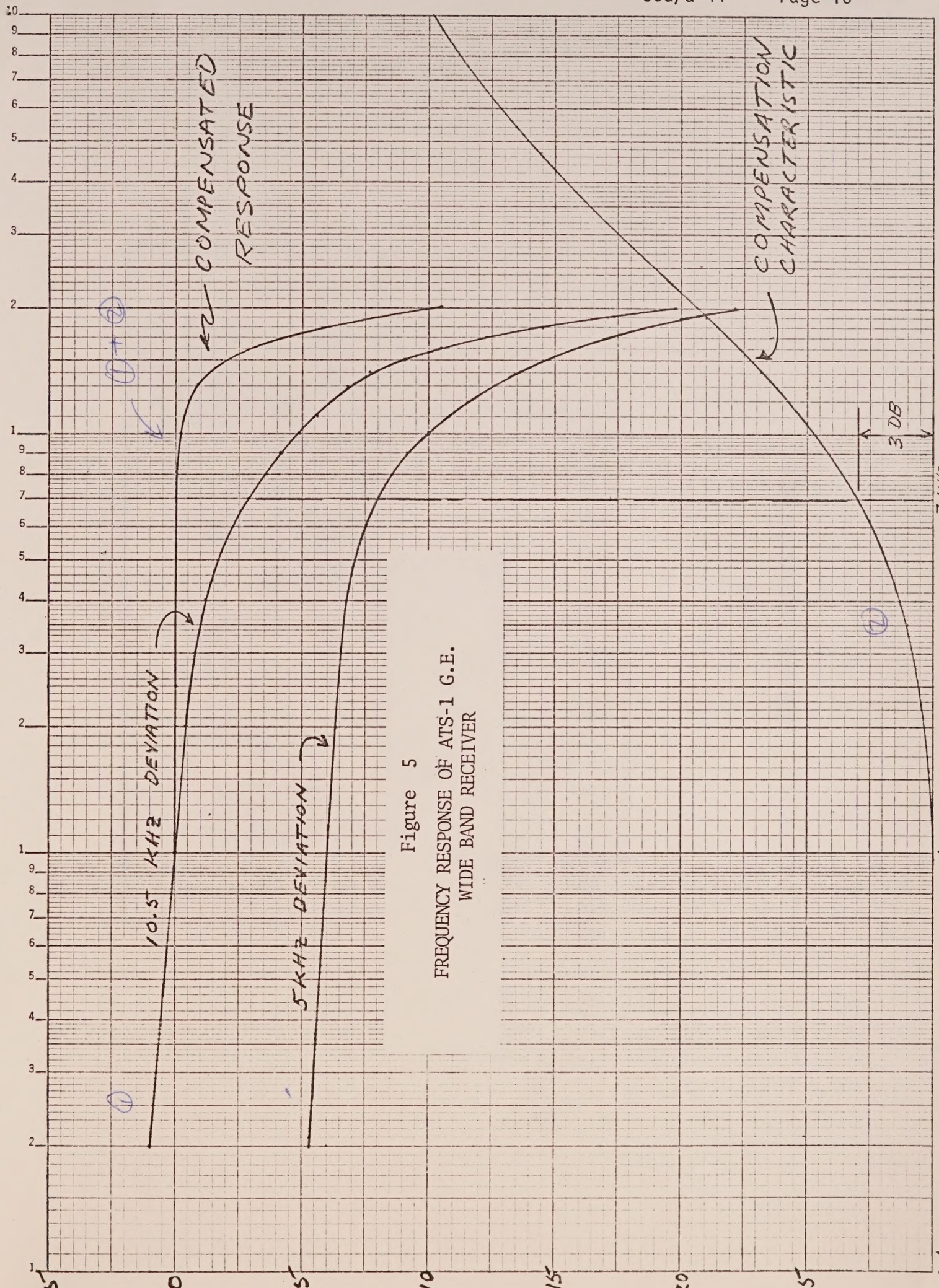

Figure 5

FREQUENCY RESPONSE OF ATS-1 G.E.
WIDE BAND RECEIVER

SEMI-LOGARITHMIC 46 5490
3 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

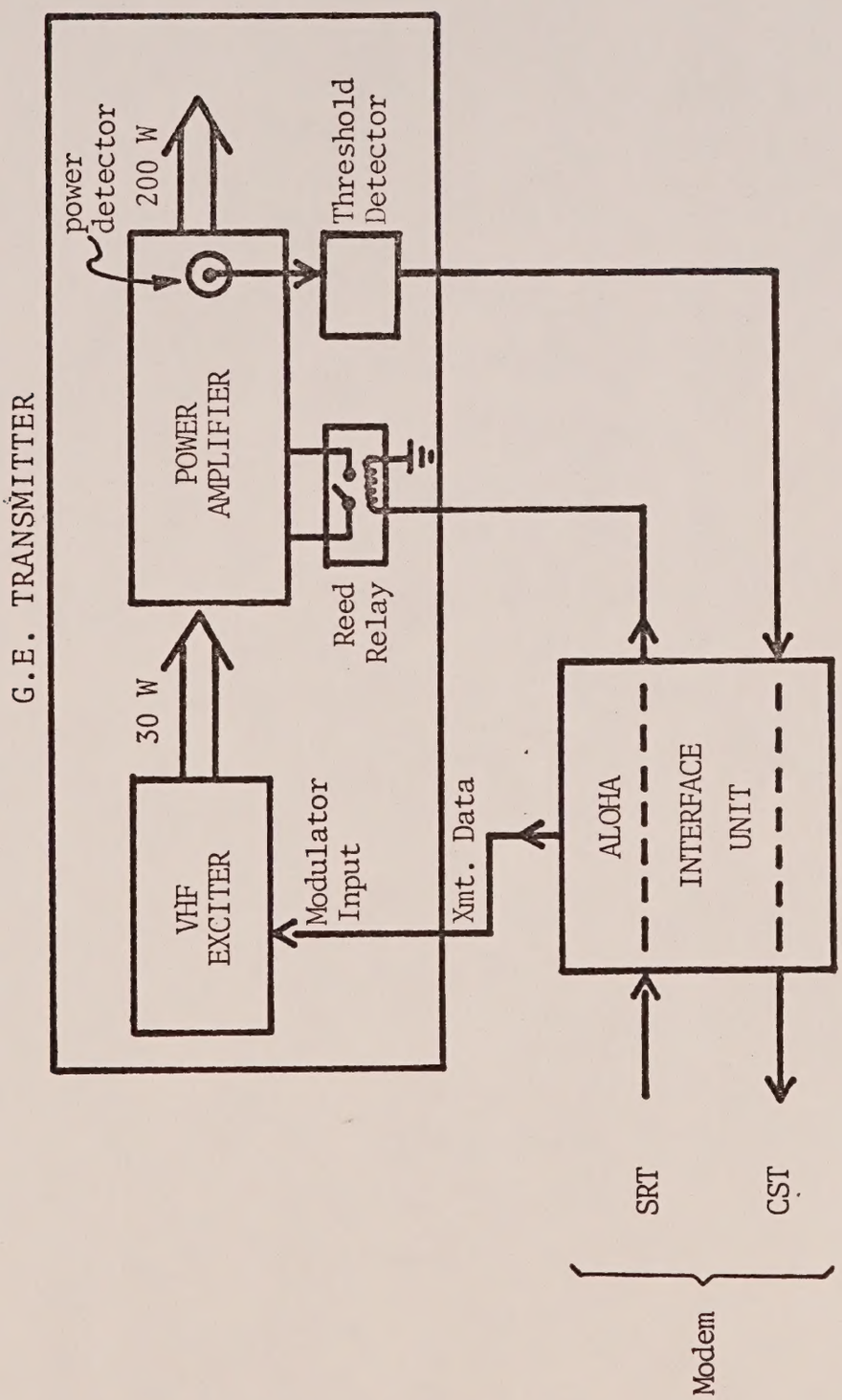

Figure 6

INTERFACE CONTROL SIGNALS